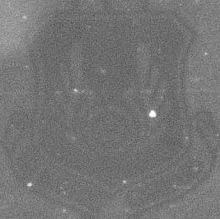


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SERVCEABLE

ECONOMIC

RETENTION

LEVELS



Irving Katz

OPERATIONS ANALYSIS TECHNICAL MEMORANDUM NO. 1

MAY 1960



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~~OPERATIONS ANALYSIS~~ TECHNICAL MEMORANDUM

6 SERVICEABLE  
ECONOMIC  
RETENTION  
LEVELS .

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10 IRVING KATZ .  
~~Operations Analyst~~

Approved for Publication  
Saul Hoch  
Chief, Operations Analysis Office

This report contains the results of an  
Operations Analysis Study. It does not  
necessarily express Air Materiel Command  
policy.

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# ABSTRACT

This paper develops a perspective of the problems to be considered when determining whether to hold or dispose of serviceable units in long supply, for recoverable types of items. It also develops a formula for determining an economically justifiable "Serviceable Economic Retention Level" for such items, and a rule-of-thumb approximation of the formula.

## TABLE OF CONTENTS

	<u>Page</u>
Abstract	1
Illustration List	iv
I Introduction	1
II Depot Level Repairability	3
Retention Levels	3
The Effect of Repairability	4
The Life Cycle of Recoverable Items	5
The Serviceable Economic Retention Level (SERL)	9
Scope of Initial Application	12
The SERL Formula	14
The SERL Rule-of-Thumb	18
Economic Resumption of Depot Repair	19
III Base Level Repairability	21
Introduction	21
Effect of Pre-Issue	21
GRL and the Excess Change Notice	22
The $Q_3$ Level and the Redefined SERL	24
The Disposal Decision	25
"B" Coded Items	28
Summary	28
IV Special Considerations	30
Expediting the Disposal	30
Marginal Costs	30
Relation to the Other Services	33

TABLE OF CONTENTS (Cont'd)

Stability of Requirements Factors	34
Interchangeable Items	36
V Motivation	38
Commander Sign-off	38
Management Indexes	38
The "Corpus Delicti"	40
VI Recommendations	42
Bibliography	43
Initial Distribution List	44

### ILLUSTRATION LIST

<u>Figure</u>	<u>Page</u>
1. Serviceable Bin with Retention Levels	6
2. Life Cycle of a Black Box in Long Supply	6
3. Modified Life Cycle of a Long Supply Item	8
4. Disposal of Serviceables	10
5. Disposal with Base Repair	24

## I. INTRODUCTION

On several recent occasions the AMC Director of Supply, Major General Frank A. Bogart (also Vice Chairman of the AF Spares Study Group), has expressed strong concern over the possibility that too many serviceable units of line items in very long supply may be held rather than disposed of by our AMAs. The type of evidence suggesting this possibility is the frequently high ratio between the Gross Retention Level and the Minimum Retention Level for a line item. This high ratio suggests that the Gross Retention Levels themselves are very high, and creates a potential for the holding of many years of supply of serviceables for some items.

When this problem came under discussion at a meeting on 7 January 1960, General Bogart asked whether the AMC Operations Analysis Office could conduct at least a literature search of relevant prior studies of disposal decision-making, to ascertain whether suitable remedies are available. Due to the press of other projects already initiated, we did not undertake anything even approximating a full literature search. However, in the course of an attempt to formulate the problem analytically, a perspective was developed which seemed to offer a basis for early action, and so this paper was written to present our approach. Because it is believed that early implementation of these ideas may be desirable, and also because the paper attempts to break new ground in AMC methodology rather than point to refinement of a well established system, this paper attempts to develop proposals which are as simple as possible. If the major concepts prevail, later work may be necessary to develop such refinements or revisions as are found to be desirable.

Concurrent with the informal briefing of MCS personnel on our approach, there has been an opportunity to do some literature search. This led to the finding that AMC Manuals (for example, AMCM 57-1 and AMCM 400-1) and AMC

Regulations (for example, AMCR 57-5 and AMCR 57-13) touch lightly on the disposal of recoverable type items. If there is not enough implementation of the disposal authority granted by these publications it may be because their concept of doing things "most economically" is too vague -- or because there is not sufficient motivation for the AMAs to give these matters high enough priority. This paper attempts to deal with both of these possibilities. The brief literature search also led to a rescinded Air Force Manual, AFM 67-8, which prescribed retention formulas for recoverable type items which this writer considers to have been inadequate conceptually as well as too complex to apply.

As a by-product of the disposal study there is evolved a picture of the life history of the recoverable line item which sheds light on present AMC practice that should be of considerable interest to the Directorate of Maintenance Engineering. From this picture could flow reasonable decisions quite the reverse of disposal, namely, for a limited number of selected items, a justification for doing repair work even though serviceables are already in long supply. Active participation of maintenance personnel is needed if sound planning is to be accomplished.

## II. DEPOT LEVEL REPAIRABILITY

### Retention Levels

Spares of recoverable type items which are in long supply in the Air Force are either retained or disposed of on the basis of two calculated stock levels. The reparable units are considered available for disposal when the sum of serviceables plus (reparables divided by overhaul recovery rate) exceeds the "Minimum Retention Level (MRL)." The MRL quantity is considered adequate for all future needs if repair of this item is continued. Serviceable units are available for disposal when the number of serviceables exceeds the considerably higher "Gross Retention Level (GRL)." This GRL quantity should be enough to meet all future needs without any further repair of this item. Much concern has been expressed because the GRLs are frequently very much higher than the respective MRLs, for example, a ratio of 10 to 1 is not considered unusual.

Since our formulation of the problem stems from these high ratios of GRL to MRL, and since these two retention levels are identical in value for any line item which cannot be recovered and repaired, this study deals only with recoverable types of items. Furthermore, the high ratios only suggest the possibility that too many serviceable units are being held, and so this study seeks the basis and the justification, if any, for disposing of serviceable units in long supply. Additional reasons for concentrating the initial study on serviceable units of recoverable type items are that most long supply dollar value is concentrated in these items, and that these same items seem to be particularly amenable to improved management on the basis of economic considerations.

A preliminary and very incomplete literature search revealed that

technical literature pertaining to disposal formulae applies most satisfactorily to items which are not recoverable. The typical approach considers the holding costs of the available units, and contrasts these with the costs for repurchase of new items at a later date. The underlying idea is that units which may be disposed of now will ultimately have to be repurchased. If holding costs are higher than repurchase costs for units that would be used at some future date, these units are considered disposable; if not they are considered to be "economically retainable." Some of the theoretical treatments are more complete than others, and these include consideration of obsolescence and deterioration costs, interest rates, and stock-out penalties.

For purposes of rough illustration, with some oversimplification, one might say that if holding costs run at 10% per year of original acquisition price, and if the total cost of reacquisition runs at 110% of unit price, disposal formulae of the kind noted would indicate that eleven years of supply could economically be retained. This weighing of holding costs against reacquisition costs is made official in the Air Force by AFR 67-61, "Management of Materiel in Long Supply," dated 21 March 1957. Paragraph 5d(5) of this regulation cites economic considerations which include retention costs, procurement costs, and net return from disposal -- but it makes no mention of repair costs.

Incidentally, units which are kept because they fall within the GRU or MRL are described as "economic retention," even though no economic considerations are involved in computing these two levels.

#### The Effect of Repairability

The inadequacy of such disposal formulae, for items with high GRU/MRL ratios, is that they require the holding costs to exceed a repurchase cost in order to demonstrate the feasibility of disposing of some units. This

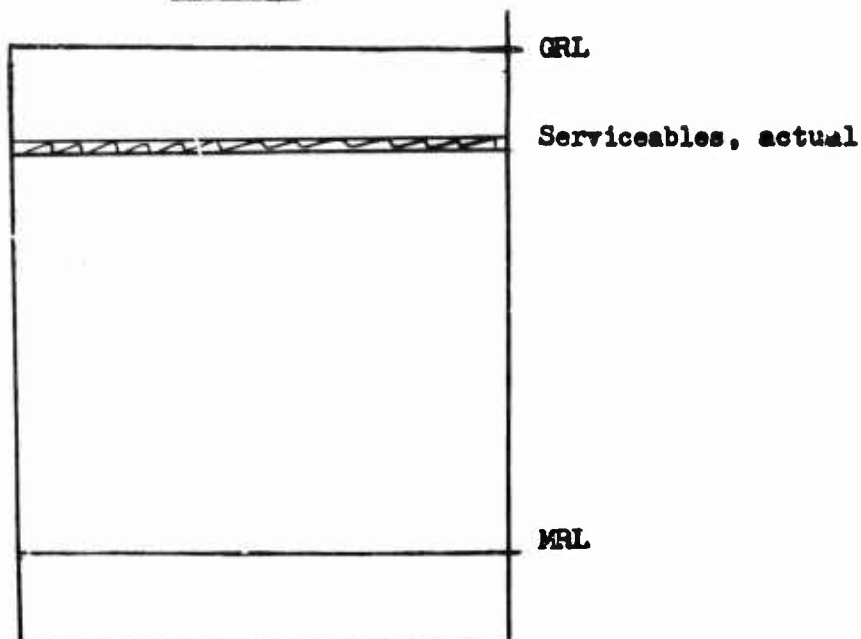
is too severe a test for recoverable types of items. When the number of serviceable units lies somewhere between the GRL and MRL, we must recognize that more repair, rather than repurchase, is an alternative to holding of serviceables. Every serviceable unit we might dispose of now will ultimately mean merely one less reparable unit to be disposed of and one more repair to be accomplished. Similarly, every serviceable unit we hold will mean one more reparable to be disposed of instead of repaired. Consequently the cost of holding a serviceable unit must be contrasted with the cost of creating a serviceable through repair. (Since we contemplate the use of no reparables except those which generate shortly before repair is to be done, and we shall dispose of the reparables generating as long as our serviceables exceed the MRL, we do not have to concern ourselves with any long term holding costs for the reparables.) Only after having reached this conclusion by preliminary analysis was it realized that General Bogart had already stated its essence at the 7 January 1960 meeting cited previously.

Reverting now to the example above, wherein eleven years of serviceables were found to be economically retainable, let us assume that repair cost equals 30% of original unit cost. It is now seen that the original test was much too severe (biased against disposal), since a comparison of holding costs with repair costs would show only three years of serviceables to be economically retainable.

#### The Life Cycle of Recoverable Items

In order to begin the quantification of the idea discussed above, let us examine Figure 1, which portrays a serviceable bin marked at GRL and MRL, and containing a quantity of serviceables between those two levels.

Figure 1

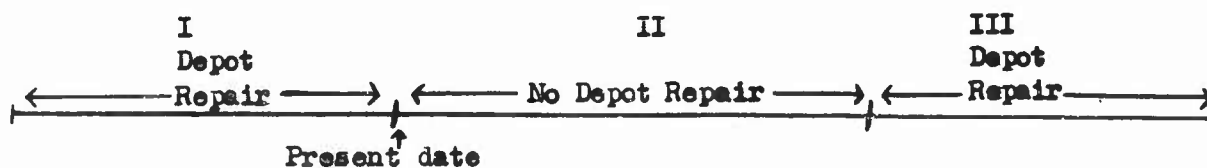


SERVICEABLE BIN WITH RETENTION LEVELS

The item is a black box which, for initial discussion, we assume can be repaired only at depot level. We also assume that this black box has been listed on an Excess Change Notice, so that we should be disposing of reparable units which are generated (and therefore excess) at base level. If the supply of reparables in the hands of the depots has been used or released for disposal, or if repair requirements are being properly managed, we would be in a period during which no depot repair is being accomplished.

Let us now transfer our attention momentarily from Figure 1 to Figure 2, where we examine the complete life cycle of this black box.

Figure 2



LIFE CYCLE OF A BLACK BOX IN LONG SUPPLY

There will have been a period of time during which this item was repaired at depot level, Phase I. This is followed by Phase II, during which these items are in long supply and are not repaired at depots, nor even sent as reparable to depots. However, since the number of serviceables is below the GRL, which is the quantity we need for satisfying demands during the full life of type, we must anticipate that in the course of time we shall have to resume depot repair, as in Phase III. The "No Repair" phase will begin when the number of serviceables builds up beyond the MRL, and will terminate when it later declines to the MRL. During the "No Depot Repair" phase, the level of serviceables shown in Figure 1 would be steadily declining towards the MRL. If the quantity of serviceables crosses back and forth over the MRL by small margins, we might conceivably have a succession of the phases shown in Figure 2; such a succession of "no repair - repair" phases could be accomplished by careful MRS scheduling, without use of the Excess Change Notice.\* However, if a major change in program or in failure rates causes the level of serviceables suddenly to go far above the MRL, we could expect to see the three sharply separated phases of Figure 2.

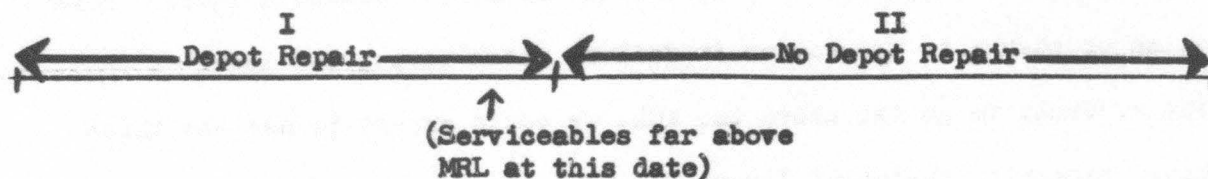
Items which suddenly cross the MRL by a wide margin should be closely examined at once, to see whether things will be happening during the "No Repair" phase which will make the resumption of repair, at a subsequent date, very difficult or expensive to accomplish. We must inquire whether the skills of the repair technicians might be lost; whether the tools and equipment for repair might be disposed of; and whether stocks of supporting repair parts (the bits and pieces) will be kept or flushed out of the system.

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\* This raises a question: how far above the MRL should stocks be before an Excess Change Notice is justified? This is discussed further in Chapter III.

It is not too hard to visualize that for many items this sort of on-again off-again cycle would be quite manageable by our specialized repair activities. The repair men might simply shift their attention from, let us say, a radio of one type and model to other radio models, using the same skills, the same tools and equipment, and perhaps even the same repair parts. With little or no effort they could resume repair of the original radio model when needed. However, it is also possible to visualize the existence of some items for which an on-again off-again approach would cause grave difficulty, for the skills would be lost and the retraining and reconstitution of the resources needed would be very expensive. For items of the latter description one would have to consider whether Figure 2 should not be deliberately replaced by Figure 3.

Figure 3



MODIFIED LIFE CYCLE OF A LONG SUPPLY ITEM

Figure 3 shows a long Phase I during which depot repairs are accomplished, followed by a terminal Phase II without depot repair. To effect a change in the life cycle of a specially justified long supply item, from Figure 2 to Figure 3, would require depot repair to be continued for a while, even though serviceable quantities far exceed the MRL, in other words, repair of items which are not needed in the short range future. This would be the kind of repair that was described in Operations Analysis Report No. 1 as work on "infinite quotient" items, which are in sufficiently long supply

(of serviceables) that we do not really need more repair now. If such repair were done, the gap between GRL and actual serviceables as shown in Figure 1 would narrow steadily, because the GRL would drop as the future program becomes smaller with the passage of time, and/or because the level of actual serviceables would rise. The gap would disappear when the quantity of serviceables reaches the latest value of the GRL, and then depot repair would be permanently discontinued, as in Phase II of Figure 3, either by issue of an Excess Change Notice or by changing the item's recoverability code. It would do no harm to emphasize once again that Figure 3 should only be deliberately authorized for selected items after careful consideration of the peculiar troubles they would generate under Figure 2, and that a very low repair priority should then be used during the latter stage of Phase I.

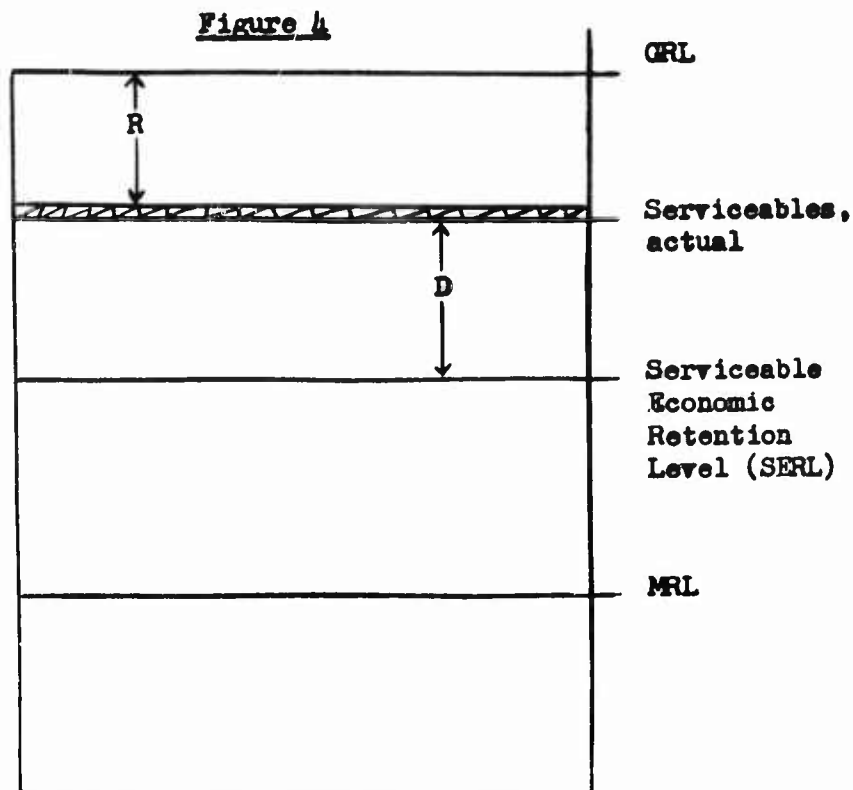
Incidentally, if we should become aware that Figure 2 is very undesirable for a particular item, but we have already entered into Phase II, it may still be possible to approximate Figure 3. Thus if the situation is noted before the skills, tools and parts have disappeared, an immediate resumption of repair may be decided upon.

The Figure 3 concept discussed above is essentially similar to decisions to make a buy on "life of type," instead of small incremental buys, in cases where re-opening of production lines would be expensive. In many cases the choice between Figures 2 and 3 can be made on a judgment basis, but if there is a great deal of money involved it may be preferable to use an objective procedure, and so we provide the latter near the end of this Chapter in the Section called "Economic Resumption of Depot Repair."

#### The Serviceable Economic Retention Level (SERL)

Let us now return to consideration of those items for which the on-again off-again approach is not a major problem, and examine Figure 4. We are

still considering items which have only depot repair.



#### DISPOSAL OF SERVICEABLES

Here we see that the actual level of serviceables falls short of the GRL, by a quantity "R". Since the GRL is the total future issue requirement for the life of the item, this means that ultimately (Phase III of Figure 2) the depots will have to repair R units. (To do this they will have to process  $\frac{R}{\text{overhaul recovery factor}}$  reparable, thus allowing for depot condemnations.

Using the symbol "orf" for the overhaul recovery factor,  $R \div \text{orf}$  reparable would have to be processed.) We can see what will happen if we dispose of serviceables even though we have not reached the GRL: If we dispose of "D" serviceables now we shall have to create D additional serviceables at a later date, by depot processing of  $D \div \text{orf}$  reparable in addition to the  $R \div \text{orf}$  already cited. The basic question to be asked is: what value of D

is economically justifiable? Another way of wording the same question is: how do we determine the Serviceable Economic Retention Level (SERL), a new kind of level, above which it is economical to dispose of serviceable units?

For discussion purposes let us assume that we have on hand a sufficient quantity of serviceables to meet our needs for six years. Let us consider the quantity ( $q_6$ ) that would be used in the 6th year, and ask whether we can dispose of it at this time. We reach the answer by considering the relative costs involved, without disposal and with disposal. Our first set of costs generates if we keep the  $q_6$  serviceables throughout this long six year holding period. Total costs by this approach would be the holding costs for the  $q_6$  serviceables over that long period of time, minus the net salvage value of  $\frac{q_6}{\text{or}}$  reparable. The second set of costs is based on disposal of the  $q_6$  serviceables now. Total costs by this approach consist of the costs to process  $\frac{q_6}{\text{or}}$  reparable through repair to obtain  $q_6$  serviceables, approximately six years from now, minus the net salvage value of the  $q_6$  serviceables which we presently dispose of, minus the net salvage value of the units condemned during the repair. The second approach does not include the acquisition costs of the serviceables being considered for disposal, since those costs were accrued in the past and we are concerned only with new costs. Thus if we had holding costs of 10% a year, a repair cost of 30% of the original acquisition cost, and only a small difference between the salvage values, we would readily find that it does not pay to hold the  $q_6$  serviceables for the 6 year time span - nor to hold anything that will be needed more than 3 years from now. SERL would thence be computed as the quantity needed for the next three years, plus stock levels.

In the example above, interest costs were temporarily ignored. In the section below called The SERL Formula they are considered. These interest costs make a "dispose" decision more probable, since they increase the holding costs of the serviceables. The SERL Formula section contains the detailed method for calculating the Serviceable Economic Retention Level (the SERL).

#### Scope of Initial Application

There is ample reason to think that a substantial percentage of the line items actually being processed through the Materiel Repair System are in very long supply, namely, between MRL and GRL. Consequently these items are candidates for the calculation of a Serviceable Economic Retention Level (SERL). We could attempt to develop cost factors which are broadly applicable to hundreds or thousands of different line items, and we might even contemplate the actual application of a disposal formula to calculate the SERL on thousands of line items. This approach has two manifest disadvantages: first, the difficulties that can be expected in obtaining valid and widely applicable cost factors, including warehouse costs, interest, obsolescence, deterioration, etc.; second, the exceedingly heavy data processing demands that would have to be levied on our already heavily taxed resources.

For these reasons it might be more judicious to consider initial application of the SERL approach to a relatively small number of items deliberately selected by each AMA or depot on the basis that they are in long supply and have particularly high holding costs and/or particularly low repair costs. For such selected items the cost factors used would not be generalized averages but would be the pertinent information actually applicable to those items. Furthermore, the chances are good that a relatively small percentage of the long supply line items would in fact yield the major part of the

potential pay-off in this area. Finally, all of the "sore thumb" items would be taken care of, so that vulnerability to criticism for retaining many years of supply on hand could be substantially eliminated.

In addition to sore thumb items, SERL could also be applied soon to sore thumb situations, such as occur when depots are being closed and decisions must be made on the shipment or disposal of numerous items of supply. For special items, the decision formula developed below could be used; for special situations, and for general use when simplicity must be stressed, the rule-of-thumb presented after the formula might be even more beneficial.

As the initial application of this SERL approach to the most promising line items begins to show results, decisions can be made regarding the rate and manner in which application should be broadened. Possibly the initial application should be viewed as a service test. If it turns out that very little disposal is actually being justified by SERL, the concept will still serve a very useful purpose -- it will help us to justify to Hq USAF, Bureau of the Budget, and Dept. of Defense the propriety of keeping our long supplies, and thereby take some of the heat off this continually irritating subject.

It is believed that our AMAs and AFDs can readily specify the items to which SERL should be applied. Incidentally, they already have the authority to follow a course somewhat akin to the SERL approach. AMCM 400-1, "Hi-Value Logistics Manual," page 10-26, authorizes them to rely on future reparable generations and repair instead of storage of serviceable assets, "when it can be determined that the criteria for retention can (thus) most economically be met." It continues: "... it will be the policy to retain sufficient assets to meet only the minimum level computed in accordance with procedures outlined above." AMCR 57-5, dated 20 Apr 1959, and AMCR 57-13 dated 14 Jan 1960, say the same thing. The troubles here are twofold:

1. No formula or objective process is furnished for deciding whether retention or reliance on future repair is more economical.

2. The policy is too inflexible. A formula designed to assess the relative economy of disposing versus holding might very well show that disposal is in order, but not all the way down to the MRL, whereas the referenced manual and regulations force a choice between no disposal and disposal all the way down to the MRL.

This QA Working Paper avoids the second trouble by introducing the more flexible SERL concept. The serviceables do not have to be reduced all the way down to MRL, but only as far down as is economically justifiable. To avoid the first trouble, the following formula is suggested.

#### The SERL Formula

The underlying logic of the formula which will enable us to quantify the Serviceable Economic Retention Level warrants a little explanation before the formula itself is presented. The key element we need to determine, before we get the SERL quantity itself, is the maximum number of years which a serviceable unit can be economically held. Stripped of refinements, this entails finding out for how many years we can accrue holding costs without their aggregate exceeding depot repair cost. We shall call this value N, and then plan to hold enough serviceables to meet all our needs for N years. Support for the N+1st year and the period following will be based on repair of the reparable generating as we approach the N+1st year.

In order to firm up the value of N we weigh all the costs inherent in each of two decisions: hold serviceables for the Nth year versus repair for the Nth year. The costs for the "hold" decision are on the left side of the formula below, and they include the following: annual holding costs and interest thereon, special or one-time holding costs, and a credit for the salvage of

the reparable not needed. The costs for the "repair" decision are on the right side of the formula, including: depot repair cost, a credit for the present salvage of the serviceables (with interest), and a credit for future salvage of units condemned during the depot repair. As mentioned previously, the total acquisition cost of the units being considered for disposal is not involved.

With this introduction, we proceed to find the largest value of N that will satisfy the formula below.

$$(V)(h) \left[ 1.04 + (1.04)^2 + (1.04)^3 + \dots (1.04)^N \right] + (H)(1.04)^N - S_r \\ \leq (V)(r) - (S_s)(1.04)^{N-1} - S_c$$

where V is the acquisition value of the serviceables to be issued in the Nth year.

N is the number of years we will hold the serviceables. Its value is

1 or more. If N is larger than the number of years remaining in

the program we will not use it, and merely set SERL equal to the GRL.

h is the percent of acquisition cost that is needed annually for holding of serviceables (including space, management, TOCs, inventories,

probable deterioration and obsolescence; interest on the total

acquisition value is not included, as this cost is already committed whether we dispose or not).

1.04 is the factor used to charge interest on new costs;  $(1.04)^2$  is

interest for two years, etc. It can be modified if an interest rate

other than 4% is considered valid. The "as of date" to which interest brings all the costs is the end of the Nth year.

H is the special or one-time cost that may be associated with the holding of the serviceables (e.g., transfer cost from a depot which is being closed).

$S_r$  is the net salvage value of the reparableables that could be disposed of if the Nth year were supported by retention of serviceables rather than by repair. The number of reparableables involved is greater than the number of serviceables, because of potential depot condemnations.\*

$\leq$  means equal to or less than.

$r$  is the percent of acquisition cost that is needed for repair. Its value is affected by the volume of repair being considered, and must reflect the costs incurred on those units which are condemned in the repair cycle. It is also affected by one's judgment whether, under a "Hold Serviceables" approach, the bases would be shipping reparableables to the depot for condemnation despite Excess Change Notices; if they would, " $r$ " need not include transportation costs, since these are incurred whether we decide to repair or to hold serviceables.

$S_s$  is the net salvage value of the serviceables that could be disposed of now if we don't hold them for support of the Nth year.\*

$S_c$  is the net salvage value of the units condemned during depot overhaul in support of the Nth year.\*

To simplify part of the actual computation, a table could readily be prepared which would give the values, for many different values of  $N$ , of the following elements in the formula:

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\* Net salvage values are often so small, in relation to holding and repair costs, that they can be ignored. In some cases they may be large enough to justify costing them out in approximate terms, such as "cash receivable minus cost of a disposal action." Only rarely would they be large enough to estimate carefully; in these cases the timing and the decentralization of the disposal action(s) would affect the net salvage value.

$$E_1 = \left[ 1.04 + (1.04)^2 + (1.04)^3 + \dots (1.04)^N \right],$$

$$E_2 = (1.04)^N \text{ and } E_3 = (1.04)^{N-1}$$

The table would look like this:

<u>N</u>	<u>E<sub>1</sub></u>	<u>E<sub>2</sub></u>	<u>E<sub>3</sub></u>	
1	1.04	1.04	1	
2	2.12	1.08	1.04	
3	3.24	1.12	1.08	
4	4.41	1.17	1.12	etc.

Once we have found the value of N we can compute the value of SERL, and dispose of serviceable units in excess of the latter.

SERL = (1) stock objective, plus

(2) quantitative requirements  
(WRM, projects, etc.), plus

(3) issues in the next N years.

The SERL formula does not include any cost for holding reparable quantities, and the SERL level does not include any quantity for priming the repair cycle, which will again be used in support of the N + 1st year and later. All that is needed is to cancel the "Excess Change Notice" early enough to prime the repair pipeline, and to resume repair early enough to support the N + 1st year; this of course also entails checking on the availability of the repair parts (EO&SP) needed for the depot overhaul.

If the SERL should turn out to be less than the MRL it must be modified so as to equal the MRL. It would hardly be wise to dispose of serviceables and keep reparables, yet we would be doing this if we disposed below MRL. Conversely, if it turns out to be more than the GRL, namely if N is greater than the number of years remaining in the program, we modify SERL so that it equals the GRL.

### The SERL Rule-of-Thumb

We recognize of course that the above formula is not so simple that every Item Control Officer can be expected to have time enough and skill enough to use it. Item Control Officers, warehouse personnel, and others could suggest candidate items which they think warrant disposal action -- recoverable type items in long serviceable supply, especially those with high holding costs and/or low repair costs. Analysts could then apply the formula. If requested, the Operations Analysis Office at Hq AMC (MCFR) would be glad to assist in the interpretation, clarification or refinement of the formula.

Situations frequently occur wherein a quick (and not too dirty) estimate of disposal possibilities needs to be made. Examples include visitations of Quarterly Review Boards, supervisory staff visits, local reviews by higher management levels, teams engaged in monitoring the distribution of stocks from depots being closed, audit or inspection teams, etc. For such purposes, a rule-of-thumb adapted from the decision formula above could be invaluable as a tool for quick screening of many items, possibly followed by more thorough review of those items which appear suspect when the rule-of-thumb is applied. To this end the following is suggested: Dispose of serviceable units which are in excess of SERL, where SERL equals serviceable stock objective plus quantitative requirements (WRM, projects, etc.) plus issue support for the next N years. The value of N is determined thus:

$$N = \frac{\text{Unit cost of depot repair minus One-time holding costs per unit.}}{\text{Annual holding costs per unit}}$$

If the computed value of  $N$  is less than 1, change it to 1. If it is larger than the number of years remaining in the program, let SERL equal the GRL. If SERL is less than MRL raise it to MRL. The "one-time holding costs" may include such costs as transfer from a closing depot to another location; also the difference between salvage value of a serviceable unit and a reparable unit, if large enough to affect the size of  $N$ ; also special rewarehousing or building costs that may have to be incurred if no disposal is made.

Cost concepts will be further discussed in Chapter IV below.

#### Economic Resumption of Depot Repair

In the discussion of item life cycles earlier in this chapter it was noted that in some cases the decision to dispose and later to resume depot repair might be hard to reach without an objective procedure. The procedure was not furnished above because the background of the SERL formula was needed first.

In developing SERL we determined that it was economical to hold serviceables in support of  $N$  years, and to rely on repair beginning with the  $N + 1$ st year, but we did not take account of the Materiel Repair System start-up costs. These may include new tools and equipment, training of personnel, lay-in of repair parts, etc. If these are large enough they might cause us to reject the use of SERL, and to keep all of our serviceables, as in the life cycle portrayed by Figure 3 above.

To decide whether disposal and later resumption of depot repair is more economical than continuing repair until stocks reach the GRL, in other words to choose between Figure 2 and Figure 3, we must evaluate two sets of costs.

1. No disposal (Figure 3): repair costs until we reach GRL, plus holding costs through life of type, minus net salvage values for all reparable

generated after we reach GRL and all items condemned in repair.

2. Disposal (Figure 2): holding costs for N years, plus repair costs from N + 1st year through life of type, minus net salvage value of serviceables disposed of now and of reparable disposed of until we reopen repair and of items condemned in repair, plus costs to start-up the depot repair process after N years without repair.

If the set of disposal costs is lower, then SERL is used. It is noted that start-up costs are not included in the SERL formula itself, for once we commit ourselves to incur them they no longer affect the incremental annual costs being tested in the SERL formula.

It is quite apparent that detailed application of the two sets of costs outlined above would be very tedious. Once again we note, therefore, that only in rare cases need we make a formal check on whether resumption of repair is economical. In the typical case, where depot repair start-up costs are moderate, SERL could be used without preliminary calculations of this kind.

If costs of the above kind are not taken into consideration, whether formally or informally, it is very possible that the high holding costs and high start-up costs will both be incurred.

### III. BASE LEVEL REPAIRABILITY

#### Introduction

The preceding chapter was limited throughout to discussion of recoverable items which are repairable at depot level only. There is no recoverability code which administratively proscribes bases from repairing items -- thus, items with a "P" code are the only ones which may be sent to depots for repair, but even the D coded items may be repaired at operating bases if they have the capability. Chapter II was therefore a discussion of a relatively small number of items which for technical reasons are beyond base level repair capability; these items were covered first because they served as an introduction to the more complicated situation faced when a line item is repairable at both base and depot.

#### Effect of Pre-Issue

An important consideration to come to grips with, before discussing retention levels on items repairable at base level, is the effect of "maintenance pre-issue stocks." Many serviceable spares are delivered to aircraft docks or repair lines through pre-issue; the stocks in the pre-issue location very often came there from base repair; and transactions of this kind are normally excluded from the "issue rate" used by Air Materiel Command in computing Gross Retention Levels. For retention level calculations by AMC, repairs and replacements which go through pre-issue but not through base supply are treated as though they did not occur.

On the other hand, many item failures which are repaired at base do get reflected in the issue rate, either because the item is not stocked in pre-issue or because the base supply reserves had to be drawn upon. It is base repairs of this kind which are supposed to be reflected when AMC requirements calculations use factors indicating the percentage returned for depot repair

and the percentage repaired at base.

In summary, our Gross Retention Level does not have a very firm and clear cut interpretation when base repair and pre-issue effects are considered.

#### GRL and the Excess Change Notice

The GRL is computed with an issue rate which does not reflect base repairs cycled through pre-issue. When serviceable stocks exceed this GRL the excess units are disposed of, the idea being that the GRL will meet all needs for life of type. Implicit in such an arrangement is the idea that pre-issue support and related repairs need to continue, but that other base repair of the item can be discontinued if stocks equal GRL.

However, the Excess Change Notice that the Air Materiel Area would issue, instructing bases to dispose of serviceables and reparable excess to local needs, would not convey this information. It is not at all clear how the bases react to these notices insofar as their repair practice is concerned. In fact, the Excess Change Notice has not been thought of by Hq AMC as a device which influences base repair practice, but only as a tool to prevent unwanted items from being shipped back to depots. It seems possible for the base repair practice to range from one extreme of discontinuing all base repair to the other extreme of making no change whatever. It is fairly clear, for example, that if an item covered by an Excess Change Notice is allowed to remain as a pre-issue item, little change in repair practice will be made.

The GRL concept as used has the effect of holding enough serviceables to make unnecessary the amount of base repair which was over and above pre-issue, but not enough to make unnecessary the base repair which was masked by pre-issue. There seems to be very little justification for making such a distinction, and the AMC procedures which are expressed through Excess Change Notices need to be improved to clarify this situation. The notices

could be worded so as to advise or instruct bases on the desired extent of base repair, reflecting actual stock conditions.

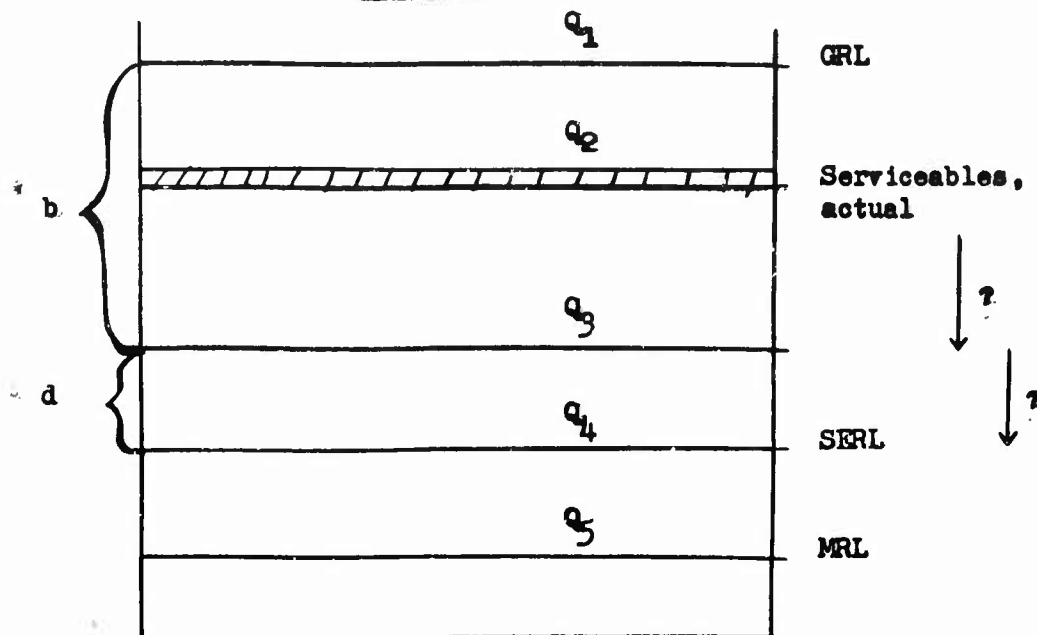
Take the particular case where stocks are below the GRL but well above the MRL; today, an Excess Change Notice would be issued instructing bases to dispose of reparable excess to local need. From the bases' point of view, this indicates the same kind of treatment of reparable as if stocks were at the GRL, yet the AF-wide needs are different. In this particular case we need total repair in the future in a quantity equal to pre-issue amounts plus the present difference between GRL and actual stocks; if stocks were at GRL we would only need future repair equivalent to pre-issue activity.

There is another problem that needs attention. The level at which serviceable stocks should be in order to justify issuance of an Excess Change Notice needs to be clarified. At the MRL level it should not be issued, since all repair possible is needed to avoid new procurement. At the GRL level and somewhat below the notice is clearly needed. It is not clear at what point between GRL and MRL the notice is first needed. In this paper we choose merely to point out this problem, not to offer a definitive answer. The answer would seem to depend upon a policy decision as to the minimum period of time an Excess Change Notice ought to be in effect before it is cancelled -- and cancelled it will ultimately have to be for all items which will later depend upon depot repair. Once this policy decision is made, for example one year might be chosen as the minimum worth while period for Excess Change Notices, procedures should be issued by Hq AMC, stating that Excess Change Notices should only be issued when the actual stock level is sufficiently higher than the MRL to allow the Excess Change Notice to remain in effect for at least the specified minimum period.

### The $Q_3$ Level and the Redefined SERL

A picture of the conditions which may prevail for an item amenable to base repair is shown below.

Figure 5



DISPOSAL WITH BASE REPAIR

In Figure 5 above, "b" represents a conservative estimate of the number of units that could be made serviceable through base level repair during the remaining life of the line item. This b value reflects the relative frequency of base repairs to depot repairs, and also reflects the wearout or condemnation frequency in base repairs. To the extent that base level repairs would not all be reflected in issue rates (that is, under pre-issue arrangements), b does not include all base repairs.

By subtracting b from the GRL we obtain the  $Q_3$  value, which is equal to the full requirement for life of type at net depot issue rate. It has particular significance, because if we stay above it we can consider depot level repair permanently closed, whereas every unit that we drop below it will have to be offset by a subsequent unit from depot repair. (The above

statement, and the rest of this Chapter ignore the repairs accomplished in the pre-issue cycle. With today's procedures these are not measurable by AMC; if appropriate changes were made they could be measured and considered as part of "b.")

The SERL value we shall use is computed the same as in Chapter II except that the N years of supply are figured at net depot issue rate, which implies that base repair is continuing whenever we apply SERL. For the sake of uniformity we can now state that SERL is always based on net depot issue rate. for even in the special case as in Chapter II where only depot repair was possible, the ordinary issue rate is the same as the net depot issue rate.

We can also state that SERL could only be larger than  $Q_3$  if N were greater than the number of years remaining in the program, and if this were so SERL should automatically be set equal to the GRL.

#### The Disposal Decision

If we were to drop our serviceables down to the SERL level we should have to generate b serviceables from base repair and d serviceables from depot repair. One of the first questions we must ask before dropping stocks to SERL is whether it will be economical to reopen depot repair lines. As stated in Chapter II this can usually be decided on a judgment basis, but if start-up costs are very high we might choose to cost the matter out in some detail.

If it does pay to reopen depot repair then we should dispose down to SERL. Once we reduce stocks to SERL, b and d become firm planning factors for future volume of base and depot repair respectively. This means that bases will continue their normal repair practices for life of type. This follows because we cannot plan fewer depot repairs than d -- if we did we would fall short of the quantity ultimately needed -- and if we planned more depot repairs than

d we would be substituting depot repairs for base repairs. Base repairs are preferred to depot repairs for the following reasons.

On the assumption that the tools and skills have already been provided to the bases' field maintenance shops and armament-electronics shops, base repair can be expected to be cheaper than depot repair first because of savings in transportation costs. Secondly, let us note a strong body of Air Force opinion which holds that maintenance capability at base shops often exceeds actual workload (presumably justifiable in terms of D-day needs); consequently, base manhour costs are being incurred whether our long-supply items are being repaired or disposed of at base level. This implies that the only base level repair costs which we need to consider would be costs of "bit and piece" repair parts; in effect, these costs alone would be the marginal base repair costs, and this contributes to a preference for base repair instead of depot repair. Third, the continuance of base repair through life of type is desirable because of the combat readiness provided by continued base capability to repair the item. Under the exigencies of combat, serviceable spares may not be in the correct location, and field expedient types of repair may be the only solution. Finally, if we cut off base repair before the item phases out we will probably have bought peculiar EO&SP parts which will be wasted; if we continue it through the program life there is some hope that new EO&SP procedures will take account of ending programs and avoid wasteful lay-ins of peculiar parts.

One problem remains to be discussed. It will tend to come up in cases where  $Q_3$  is low (namely base repair is extensive). Here one might try to avoid holding serviceable stocks as long as N years by using them up at a faster rate, namely by temporarily stopping base repair and issuing stocks from depots at the gross issue rate instead of the previous net depot issue

rate. This would lead to a major difficulty: after some years the bases would have to resume repair, and it is believed that such a resumption would be far more difficult than it is at depot level because it involves so many more separate repair facilities. In addition, it would reduce the bases' combat readiness with respect to emergency needs for repairing the item. Finally, it is not desirable because we have no effective administrative means to turn base repair off and then on; the Excess Change Notice is not reliable, and making the item non-recoverable would make it exceedingly difficult to resume repair later on.

If start-up costs preclude reopening of depot level repair we will not wish to stop and then re-start depot repair. Under these conditions if we are below the  $Q_3$  level, we should keep depot repair going (at a low priority) until we finally reach a recalculated (due to passage of time)  $Q_3$ , and then permanently discontinue depot repair. This corresponds to Figure 3 above. If we are above the  $Q_3$  level, we can permanently stop depot repair and dispose down to the  $Q_3$  level.\*

In the cases where depot repair is being permanently stopped we might find that some reparable are still (erroneously) flowing back to depots, the Excess Change Notice notwithstanding. Changing the item's recoverability code to B might be a better way of assuring that this flow is stopped, if we can be sure that the B code will not cause the bases to expand their repair capability by adding tools, skills, etc.

As mentioned above, we should in no case dispose of serviceables below the MRL until extended studies which cover disposal of reparable and cost of new procurement indicate whether this may be attempted. Such studies have been started by Hq AMC's Operations Analysis Office.

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\* In those cases where "N" would be more years than the remaining program, disposal could only be considered if base repair costs were available.

### "B" Coded Items

In those cases where the recoverability code is B, no SERL can be computed since there are no depot repair costs available. A comparable approach could be used, involving base repair costs instead. After we obtain more experience using SERL on D-coded items it might prove to be worth while to negotiate with the operating commands, to choose between the following possible procedures for B-coded items:

1. Dispose down to the  $Q_3$  level, or
2. Do not dispose of B-coded serviceables below the GRL (presently in effect), or
3. Obtain base repair cost data, and compute a level comparable to SERL on this basis.

### Summary

The discussion in this Chapter is necessarily lengthy because it seeks to describe and to justify certain conclusions. Once these conclusions are reached, and for application purposes, it would seem to be desirable to compress the conclusions into a few brief statements.

1. SERL should be computed, by formula or rule-of-thumb, for selected D-coded items. The description of its calculation in Chapter II should be followed, remembering the following:

- a. Use net depot issue rate when computing issue support for the next  $N$  years.
- b.  $N$  must always be 1 or more. If it is more than the years remaining in the program, set SERL equal to the GRL.
- c. If SERL is computed to be lower than MRL, replace it by the MRL value.

2. Dispose of serviceable units of D-coded items down to SEHL if the start-up costs to resume depot repair would not be prohibitive.

3. If resumption of depot repair would not be economical, dispose of D-coded items down to  $Q_3$ ; if already below  $Q_3$ , continue depot repair until a new  $Q_3$  is reached. However, if "N" would be more years than the remaining program, negotiate with operating commands on the basis of base level repair costs.

4. Negotiate with operating commands for B-coded items.

#### IV. SPECIAL CONSIDERATIONS

##### Expediting the Disposal

It might be well at this time to recognize that official use of a SERL would increase the amount of stocks that we have in an overtly recognized excess position. However, actual savings of the holding costs do not come about through such recognition, until and unless actual disposal action is consummated. To the extent that we have huge backlogs of undisposed excess, and that more serviceables would simply be added to those backlogs without any speeding up of the movement out of the system, we will have accomplished no good. In fact it is conceivable, if there is a very long delay before the final disposition is made, that the items which are finally moved out are leaving uneconomically, since the remaining holding costs may no longer exceed the competitive repair costs. In short, lead time or execution time is of consequence in this kind of action; if actual holding costs continue to be incurred during the period in which the formula assumed they were reduced to zero, the savings potential of a good disposal will not be realized.

##### Marginal Costs

The formula and the rule-of-thumb provided by this study are only useful when and if appropriate cost data are available. Full treatment of the cost concepts and related data processing are not being undertaken in this paper, in order to permit the fundamental ideas discussed herein to be assessed without undue delay. Suffice it to say, at this time, that holding costs are extensively discussed in AFM 67-8, "Uses of Financial Data in the Management of Depot Inventories." The manual was rescinded in

1958, but its treatment of this subject (Chapter VII, Section II) is still useful as background.\*

Some general statements on cost concepts are felt to be necessary, however. Most efforts to use cost data are based on average cost, and so would this SERL approach if it were being applied to many thousands of items. However, the concept of marginal cost needs special stress, particularly when we are dealing with sore thumb items and special situations. In simple terms, we need to deal with the cost differences between our alternatives, and use cost figures adapted to the circumstances.

For example, let us discuss the depreciation costs of a warehouse. If we disposed of items in long supply and then ran the warehouse partially empty, we would not be saving any warehouse depreciation; the holding cost to be used in the SERL formula in such a case should omit this cost element. Interest is another good example: since we have already borrowed the money to buy the items we now find in long supply, and the interest charge on that money is with us regardless of whether we now dispose of long supply quantities, the holding cost in a disposal formula must exclude interest payable for the original acquisition.

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\* AFM 67-8 also provides formulae for economical retention levels, including recoverable type items. The SERL concept is considered to be superior to the manual's approach for recoverable type items because the latter calls for continued current repair on long supply items, which is itself grossly uneconomical, and because it does not take account of end-of-program impact on requirements. It does not therefore take cognizance of the fact that units disposed of will be replaceable by a corresponding increase in units repaired, and therefore does not use the direct trade off between repair costs and holding costs. The SERL approach, which defers the overhauls until they are needed and also reflects end-of-program effects, yields improved quantities as the "economical retention level" compared to those obtained by AFM 67-8.

If disposal of a very bulky holding of serviceables would preclude the need for a major re-warehousing or the need for a new building, the holding costs of those serviceables (to be used in the left side of the formula above) may properly include the costs of such problems. For descriptive purposes this author thinks of these unusual costs, which affect the marginal costs greatly, as "consequent costs" - the costs of the consequences of holding. As indicated above, in special cases the formula should use holding costs which include these "consequent costs." The rule-of-thumb can include them in the one-time costs or in the annual costs, wherever applicable. Decision to repair may also involve "consequent costs," to be included in the right side of the formula; however, the costs to resume depot repair of an item would usually not be counted in computing  $N$ , since resumption of depot repair will already have been determined to be desirable and the start-up costs don't influence the quantity of repair to be done.

This last example reveals something important about these consequent costs: we cannot count them in reaching a "hold versus repair" decision unless they affect us differently for the two different choices we might make. To illustrate, let us assume that holding all our serviceables would require a re-warehousing; by adding the cost of the re-warehousing to other holding costs and then comparing with the alternative repair costs we might conclude that we should dispose of a certain number of serviceables. However, if the remaining serviceables are still in such condition that the re-warehousing must still be accomplished, we did not reach the correct conclusion about the number to dispose -- the re-warehousing cost should have been left out of the calculation entirely.

One other special case warrants particularly active consideration. At the time when major trans-shipments of stocks are being considered, such as

occur when depots are being closed, excellent opportunities for economically justifiable disposal may be found. Costing the "hold" alternative would have to include the "consequent" shipping costs. On the other hand, if time does not permit a careful disposal program, with all its preliminary screening of DOD and other government agencies, nor commercial sale at a reasonable price, then costing of the "dispose" alternative may have to reflect a scrap return (perhaps 1% of original value) instead of some higher return.

#### Relation to the Other Services

The reference to DOD above brings up some very interesting possibilities which are too complicated to resolve in this initial paper, but which are too important to pass without mention. In the cost formulae, most salvage values would be very small, and the cash return to the Air Force would usually indeed be small. However, if the item is in fact needed by other government agencies, and precludes a buy on their part, then the benefits the taxpayer receives from the Air Force disposal need not be small. This raises the question of whether the "costs" we consider are to be costs to the Air Force or costs to the taxpayer. Since we are fundamentally weighing as alternatives the disposal by the Air Force of some serviceable units (and a later repair of that same quantity) versus retention (and the later disposal of an equal number of reparable units), one might think that for line items needed by another government agency the whole issue boils down to whether the units will be repaired by the Air Force or by the other agency. Actually, the potential benefit to the taxpayer is increased if we choose to apply SERL and use a high (taxpayer type) net salvage value for the serviceables released, thus disposing of many serviceables now. There are two reasons for this:

a. The serviceables are available now, whereas the associated reparable will not be available for a considerable period of time -- and may be too late to preclude the other agency's buy.

b. The other agency may be working under ground rules which permit them to accept serviceables but not reparable.

Looking at the other side of the coin, when other agencies are releasing serviceable units of a recoverable type item, we should accept them up to our SERL rather than up to our Gross Retention Level. In this instance, however, if the serviceable units not accepted by us will actually go to salvage, the SERL formulae should use the low net salvage value reflecting the low return to the taxpayer if the Air Force does not pick up some of the units.

#### Stability of Requirements Factors

The factors and the program life used in computing our present GRL and MRL are subject to change. If the net effect of all such changes is a reduction in requirements, especially such a reduction that would later cause us to dispose of serviceables, then we are certainly better off for having disposed down to SERL now and thereby having avoided totally unnecessary holding costs. Conversely, if the net effect of the factor changes is an increase in requirements, we may suffer some loss from having used SERL. So long as the quantity we still have is equal to the MRL, computed under the new factors, our loss is either small or zero. For example, if the only factor that changes is an extension of program life from six years to eight years, and we still have as much as the new MRL, the original SERL decision would have been completely valid; the holding costs for the additional two years could not have been justified, and the continuance of repair during the last two years would have been decided

upon even at the time the SERL was computed. On the other hand, if the issue rate goes up, the units disposed of would actually have lasted fewer than N years; in this case we will be penalized by some extra repairs to be accomplished.

Overall, since our procurement, distribution, etc., all presume stability and validity of the programs and factors we use, there seems to be little reason to reject this presumption just for disposal. Therefore, it does not seem that unpredictable changes should mitigate our interest in using SERL.

One special precaution is thought to be worth while, however. There have been cases where "issue intervals" used for retention level computations have been much higher than could properly be justified by the actual Air Force experience with an item. For example, an item used in only one aircraft model may have a computed issue interval of 4,000 flying hours at a time when the oldest aircraft have themselves been flown no more than 1,000 hours. It is entirely possible that the failure pattern on this item is age-related, and that although early failure rates were low all the items will fail before 2,000 aircraft hours are reached; the issue interval will later have to be revised downward drastically. It is strongly recommended that issue intervals, when used for computing retention levels, be adjusted downward so they do not exceed the flying hours accomplished by the bulk of the fleet. A similar step would be taken for items introduced as engineering changes later in the life of the fleet. Thus if a retrofit program were accomplished on an aircraft model which has average flying time of 35 hours a month, the maximum issue interval to be used for retention levels would be 35 times the number of months since the retrofit. Incidentally, this precaution applies to the MRL as well as the GRL, even though issue rates or issue intervals are implicitly rather than explicitly involved in the MRL.

### Interchangeable Items

In order to complete this paper early enough to serve management needs, very little attention has been given as yet by the author to the special problems which arise when line items are interchangeable. Only two facets of this problem have thus far been noted, but they seem worthy of mention.

In recent discussions of the policy for reclassification of Hi-Valu items to Cost Category II, there has been active discussion of the relative merit of an alternative course of action: retention of the Hi-Valu classification and disposal of subsidiary items, in order to reduce the number of separate line items in the logistic system. Considerations of this alternative seem to be based in part upon the number of available spares of the subsidiary items, but not upon the number of operational units of this subsidiary item actually installed in the active fleet (of aircraft or other end items).

Deletion of subsidiary line items without regard to installed configuration may prove most ill-advised for a family of interchangeables with stocks at all close to their composite Minimum Retention Level. Living out the life of type depends upon repair and re-use of units which will fail in the future, and if many of the installed units are in the subsidiary item configuration we may be forced to accept the deleted subsidiary item back into the system.

Unfortunately, consideration of the installed configuration is usually difficult or impossible, due to lack of appropriate information. Consequently reclassification of interchangeable item families from Hi-Valu to Category II would seem to be a more feasible solution than disposal of subsidiary items in most cases of Hi-Valu long supply.

A second point to be made is in connection with a possible policy which

would call for disposal of serviceable units of a subsidiary item if above the individual MRL as calculated for that item alone. This could lead to cases where we dispose of serviceable units in one period and find it necessary to repair identical or equivalent units in a period immediately following; in other words, the incurring of unnecessary repair costs. Even worse, the disposal of serviceables on this subsidiary could sometimes cause the stock position of the entire interchangeable family to drop from above the family's MRL to a point below it; this could result ultimately in a need for new "buys" which should have been avoided.

## V. MOTIVATION

There is reason to believe that the mere availability of concepts and formulae would not have a sufficient effect on actual AMA behavior patterns in disposal of serviceables. The management environment is such that most Item Managers consider the penalties of shortages far more earnestly than the penalties of overages - this contributes to the creation of the overages to begin with, and subsequently to a very conservative or hesitant attitude about getting rid of them. If disposal action of real magnitude is to be obtained we shall have to create additional motivation for it. In this Chapter we shall discuss two ways of doing this, on the assumption that the SERL concept has been fully implemented.

### Commander Sign-off

One simple and direct way to motivate greater disposal activity would be to require AMA commanders to personally approve all cases where their Item Managers wish to keep serviceables at a level higher than 110% of SERL. This approach would forcefully place the burden of proof on those Item Managers who so fear the consequences of a shortage that they studiously avoid appropriate disposal action.

### Management Indexes

A second way to reduce the apathy or active resistance against suitable disposal activity is to strengthen its position as a major subject for regular management scrutiny and emphasis.

In Chapter III of Supplement No. 1 to Operations Analysis Report No. 1,\*

\* "Some Production Aspects and Stock Level Results of the Materiel Repair System," Lt. P. F. Myers and I. Katz, Hq AMC (MCFR).

there is a discussion of the serviceable stock levels of MRS items. This includes a suggestion that an objective procedure for examining the trend towards more line items with the correct level of serviceable assets would be a very useful management tool. The final sentence of that report states: "It would motivate more transfer of long-supply Hi-Valu items to Category II, more deferral of unneeded repair, more expediting of short items, and accelerated disposal of excesses." Within the framework of the present report, it might be well to elaborate upon the manner in which disposal of excesses could be motivated by an adaptation of this approach.

The basic tool might be an index for use in the new Monthly Commander's Digest. This index could be based on the current status of all recoverable line items which had serviceable assets in excess of 110% of their respective SERLs at the beginning of the fiscal year, as presented in an "initial list." From the most recent data, a quarterly determination could be made of the number of these items for which the Managers had released to the Redistribution and Marketing function enough units to drop the serviceable level down to 110% of SERL or below. The index would be the percent of the line items on the initial list which had been released in this manner.

In order to monitor disposal activities until the excess units are actually purged, not merely released by Item Managers, an auxiliary index could be used. This index would have to reflect the long average lead time involved in screening all the government agencies who might need this item and the time for effecting the final sale. It would therefore be based on the current status of all recoverable line items which had serviceable assets in excess of 110% of their respective SERLs as of the beginning of the fiscal year preceding the current fiscal year, i.e., last year's "initial list." From the most recent data we would then examine each of

these line items to see whether serviceable assets had actually dropped below 110% of SERL. The auxiliary index would be the percent of these line items which had so dropped.

When and if Reparable Economic Retention Levels, similar to the SERL in concept, are designed and implemented, similar indexes could be constructed for them. (Preliminary work related to the long supply reparable units has been accomplished, and a Rule-of-Thumb devised.) If preferred, composite indexes could be used that reflect the combined status of serviceable and reparable units, measured against appropriate economic retention levels. With sufficient attention of this kind it seems reasonable to believe that purging of unneeded stocks from the Air Force would occur in a far more timely fashion than heretofore.

#### The "Corpus Delicti"

Excess and long supply situations which develop in the Air Force may occasionally be caused by poor management, but can also be caused by a wide range of circumstances which even the most superior management could not preclude. Examples of the latter include program changes to reflect new international situations, unpredictables in the development of new weapon systems, lack of predictability in the failure patterns of individual items, and most important, the simple phasing out of weapons as they obsolesce.

There is some evidence to support a belief that private industry, although not subject to as many severely unpredictable influences as military logistics, experiences long supply problems of comparable proportions. Be that as it may, military logistics is a public trust, and its long supplies are frequently portrayed to the public as "prima facie" evidence of poor management, the "corpus delicti" to prove something wrong has been done. Criticism can originate from examination of the materiel

which has been disposed of by the Air Force, and also from scrutiny of long supplies being retained. One prime difference between these two sources of criticism may be noted: a tendency towards disposal actions creates one-time risks of criticism, whereas a proclivity towards retention of long supplies creates a chronic and long-time vulnerability of increasing proportions.

Personnel concerned with the development of credibility in the soundness of Air Force management and budget requests do well to give increasing attention to the psychological effect of the "corpus delicti." One indication comes from a recent letter in which the Office of the Secretary of Defense announces that increasing use is being made by them, BOB and Congress of the "Requirements-Inventory Analysis Report" (formerly known as the Segmentation Report). This report gives clear evidence of the billions of dollars of inventory held and forthrightly labeled "excess" or "long supply." Accelerated disposal would seem to be in order, especially by an approach like SERL which provides a rational justification for such action, lest increasing attention to this report lead to decreasing confidence that military budgets are valid.

## VI. RECOMMENDATIONS

It is recommended that:

1. Items be selected by each AMA/AFD for experimental application of SERL.
2. Application of SERL to phase-out depots be vigorously, but carefully, pursued.
3. The use and impact of Excess Change Notices be further studied and improved, so as to improve ~~the~~ correlation with base repair operations.
4. Study in process on methods of obtaining and applying necessary cost data be continued with necessary priority.
5. Operating commands be advised of new concepts as they are firmed up, and be consulted in relation to effects on base repair and use of base repair costs.
6. Issue intervals or issue rates used for computation of retention levels be modified as discussed in Chapter IV.

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